PATENT SPECIFICATION

(11) 1 236 372

DRAWINGS ATTACHED

1 236 372

(21) Application No. 30150/67 (22) Filed 29 June 1967

(23) Complete Specification filed 30 Sept. 1968

(45) Complete Specification published 23 June 1971

(51) International Classification H 01 q 1/28

(52) Index at acceptance

H4A 1U1 3M 6M

(72) Inventor JAMES QUINTARD CALKIN

(54) IMPROVEMENTS IN OR RELATING TO RADIO AERIALS FOR AIRCRAFT

(71) We, HAWKER SIDDELEY AVIATION LIMITED, a British Company, of Richmond Road, Kingston-upon-Thames, Surrey, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to radio aerials for aircraft.

Low frequency radio aerials are of considerable length and usually buried in the fuselage of an aircraft. On the other hand, U.H.F. and V.H.F. aerials are normally external aerials projecting from the aircraft. U. H. F. aerials are only about four or five inches long and present no structural problem but V.H.F. aerials, which may be eighteen inches or more in length, are susceptible to induced aerodynamic vibrations leading to a risk of the aerial snapping off at the base. Moreover, there is now a requirement for employment of the 30—100 m/cs band involving an aerial in excess of forty inches long, with consequently a serious increase in the likelihood of structural failure. It is an object of the invention to provide a design of aerial that will overcome the difficulty.

According to the present invention, there is provided an aircraft radio aerial in which the primary radiator forms part of an elongated flexible member of streamline section projecting as a cantilever from a supporting surface to which the root of said member is secured, which member is raked back, in relation to the normal direction of forward travel of the aircraft, from its root to its tip, and characterised in that said member is flexible transversely but shows substantially no torsional deflection about its raked back longitudinal axis when the aircraft is in flight.

In this way, if the member deflects under any loads, whether they are caused aerodynamically or as a result of lateral acceleration, a restoring aerodynamic force will be caused due to the inclination of the mean chord of the airfoil to the direction of flight. This effort will occur to an appreciable extent only with a member which, although flexible transversely, will not display any significant twist.

Structurally such members can be produced by introducing the required torsional stiffness in a conventional way while still retaining sufficient lateral flexibility. Alternatively, a somewhat light, though possibly more expensive member can be constructed, where the longitudinal neutral axis of torsional flexure coincides both with its mass axis and its axis of aerodynamic loading. By permitting the structure to deflect in the prescribed way bending loads near the root can be reduced by as much as 60 to 70 per cent. and thus there is no difficulty in providing aerials of the required length.

Forms of construction in accordance with the invention will now be described by way of example with reference to the accompanying drawings, in which:—

Figures 1, 2 and 3 are respectively a front elevation, a side elevation and a plan of one form of aerial,

Figure 4 is a front view of a second form of aerial,

Figure 5 is a side view of the aerial of Figure 4, and

Figure 6 is a view in section on the line 6—6 of Figure 5.

Figures 1, 2 and 3 show an aerial as proposed which projects as a cantilever from a surface 13. The thick outline 11 shows the aerial in its normal position and the thin outline 12 shows the aerial deflected. It will be clear from Figure 3, how air-flow which is parallel to the centre line of the undeflected airfoil will tend to restore the deflected member back to its normal position, by reason of the rake back of the aerial shown in Figure 2.

The aerial is designed like any other airfoil-shaped cantilever structure except that an exceptional amount of torsional rigidity is provided, for instance by using a fairly substantial skin thickness over the whole of the surface. The total foil thickness, how-

ever, must be sufficiently modest to permit the desired degree of deflection to occur without excessive root loads being generated.

Another construction of aerial is shown in Figures 4 to 6.

The aerial there illustrated is a thin tapering blade member 14 of streamlined cross section adapted to be mounted on an aircraft with a rake back of some 40°. Therefore, as in the case of the arrangement of Figures 1 to 3, if the aerial bends laterally but without twisting there is immediately a considerable aerodynamic load on the blade 14 tending to return it to its undeflected condition. The bending loads at the base 15 of the aerial will therefore not reach critical values.

In order to achieve practical absence of twisting under aerodynamic loads the blade 14 is made dynamically stable. That is to say, the longitudinal neutral axis of torsional flexure (i.e. the axis about which twisting would take place if the blade twisted), the mass axis and the axis of aerodynamic loading all lie coincident with one another at the location 16. For a given streamline aerial section the aerodynamic loading axis will usually lie somewhere considerably forward of centre. In order to make the axis of flexure concident with it, it is necessary to concentrate the stiffening bulk of the structure forward; likewise the mass axis is adjusted to the required point by keeping the trailing portion of the structure light and placing high density material as far forward as possible.

The best way to carry out the necessary calculations for an aerial of given external shape is to find out the amount of deflection compatible with the maximum stress acceptable by the material chosen. This in turn will enable the aerodynamicist to determine the loading at each section. If it is then assumed that the whole surface of the aerial consists of sheet metal, or perhaps high strength plastic, as thin as could be used in practice, the actual deflection in bending and torsion can be worked out. The bending deflection will probably exceed that previously assumed and in addition there will be torsional deflections as the flexual axis of the shell will be well aft of the loading axis. The next step, therefore, will be to add additional material to the forepart of the section such as to reduce the actual deflection to that which was originally assumed and to locate this additional material sufficiently far forward as to bring the flexual axis forward until it coincides with the aerodynamic loading axis. In most cases it will be found that this additional material can, in fact, constitute a solid spar extending not quite to the nose of the section thus leaving some room to incorporate such mass balance as might be required. The mass balance can conveniently consist of tungsten powder set in some suitable resin.

The drawings show a typical section obtained in the way described. There is a thin stainless steel skin 17 and from a point back from the leading edge rather less than 30% chord this is internally supported by honeycomb filling 18. A honeycomb does not contribute materially towards bending or torsional strength but it merely supports the trailing portion of the section to prevent buckling under load. Forward of the honeycomb is a solid stainless steel spar 19 and forward of the spar 19 is a space 20 available for mass balance. The chordwise depth of the spar will vary along the length of the aerial.

There are other ways of constructing an aerial according to the invention. For instance, one can start with two halves consisting each of a fairly thick skin, either machined or chemically milled so as to leave only a very thin part where thin sheet is all that is required. Where the half section is left at the original thickness the two halves would make either a solid spar or one which is very nearly so.

Alternatively some of the section could be replaced by a plastic supported by a solid metal spar, the position and size of which would be calculated as before. In either of these alternatives those parts of the section where the skin or outer wall was purposely left thin would have to be supported internally by a substantially non-structural filling medium.

WHAT WE CLAIM IS:—

1. An aircraft radio aerial in which the primary radiator forms part of an elongated flexible member of streamline section projecting as a cantilever from a supporting surface to which the root of said member is secured, which member is raked back, in relation to the normal direction of forward travel of the aircraft, from its root to its tip, and characterised in that said member is flexible transversely but shows substantially no torsional deflection about its raked back longitudinal axis when the aircraft is in flight.

2. An aerial according to claim 1, wherein said member is designed to have its longitudinal neutral axis of torsional flexure substantially coincident with its mass axis and its axis of aerodynamic loading.

3. An aerial according to claim 2, wherein said member comprises a thin skin internally stiffened and loaded near the leading edge.

4. An aerial according to claim 3, wherein said member embodies a solid spar near its leading edge, a space within the skin forward of this spar for mass balance purposes,

and honeycomb filling material within the skin aft of the spar.

5. An aerial according to any one of the preceding claims, wherein any lateral deflection of the member whilst the aircraft is in flight produces an aerodynamic restoring load on the member by reason of the streamline section of the member, its rake back, and its substantial absence of twist.

6. An aircraft radio aerial substantially as described with reference to Figures 1 to 3 or Figures 4 to 6 of the accompanying drawings.

For the Applicants,
LLOYD WISE, BOULY & HAIG,
Chartered Patent Agents,
Norman House,
105—109 Strand,
London, WC2R OAE.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1971.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

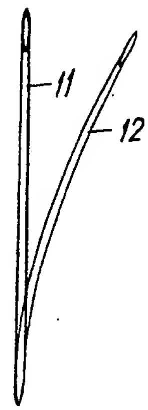


Fig.3.

Fig.1.

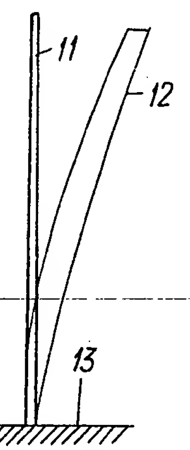
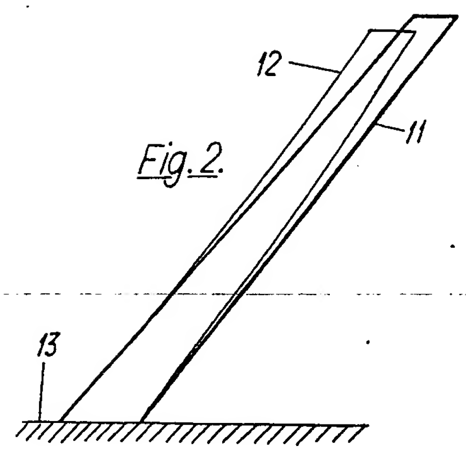


Fig.2.



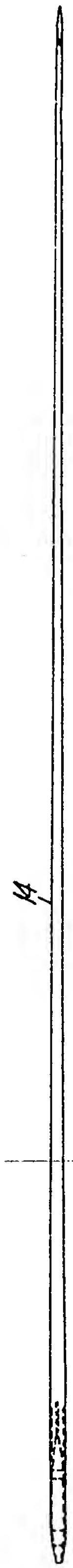


Fig.4.

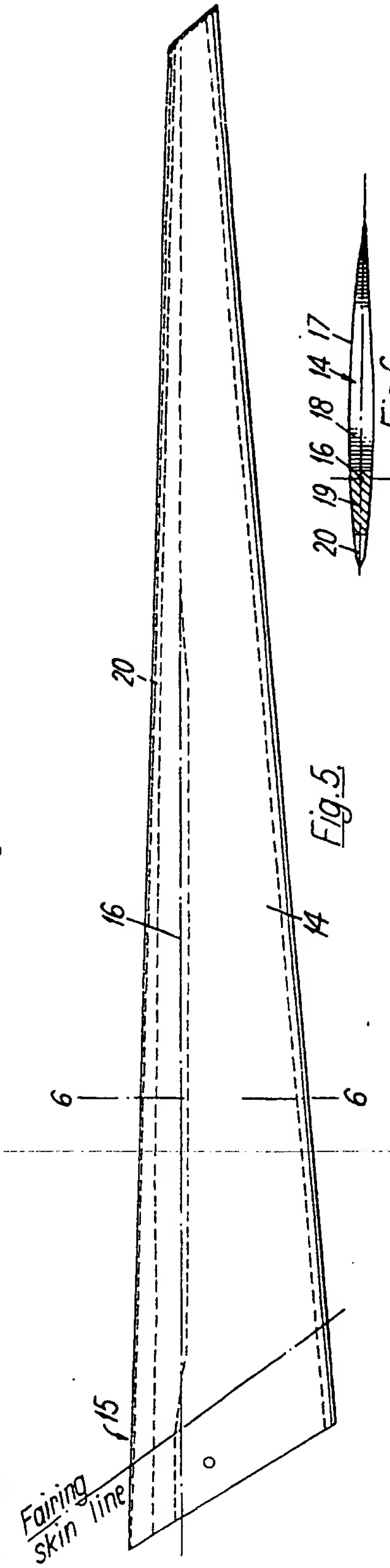


Fig.5.

Fig.6.